

**NOAA  
FISHERIES**

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## 2.5 CCLME – Ecosystem data from the CCLME Rockfish surveys

John Field, Groundfish Analysis Team,  
Fisheries Ecology Division



April 19, 2016

# Rockfish Recruitment and Ecosystem Assessment Survey

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## ***Primary research questions***

- Develop abundance estimates for Young-of-the-Year (YOY) rockfish and other groundfish for pre-recruit indices in stock assessments (Assessment survey)
- Improve our understand of the physical and biological ecosystem factors that lead to strong or weak year classes (Process studies)
- Improve our understanding of the spatial and temporal variability in the micronekton (forage) assemblage, including the role of YOY rockfish and other groundfish, as related to climate forcing and predators (Ecosystem studies)

## ***Resources***

- Staffing (~2 FTEs, additional team support, collaborators, partners)
- Funding sources – Core funding and ship time supports survey and primary objectives (recruitment indices), leveraged collaborations within/ among centers and with other institutions to develop ecosystem objectives and products

## Focus on six of the eight Terms of Reference questions

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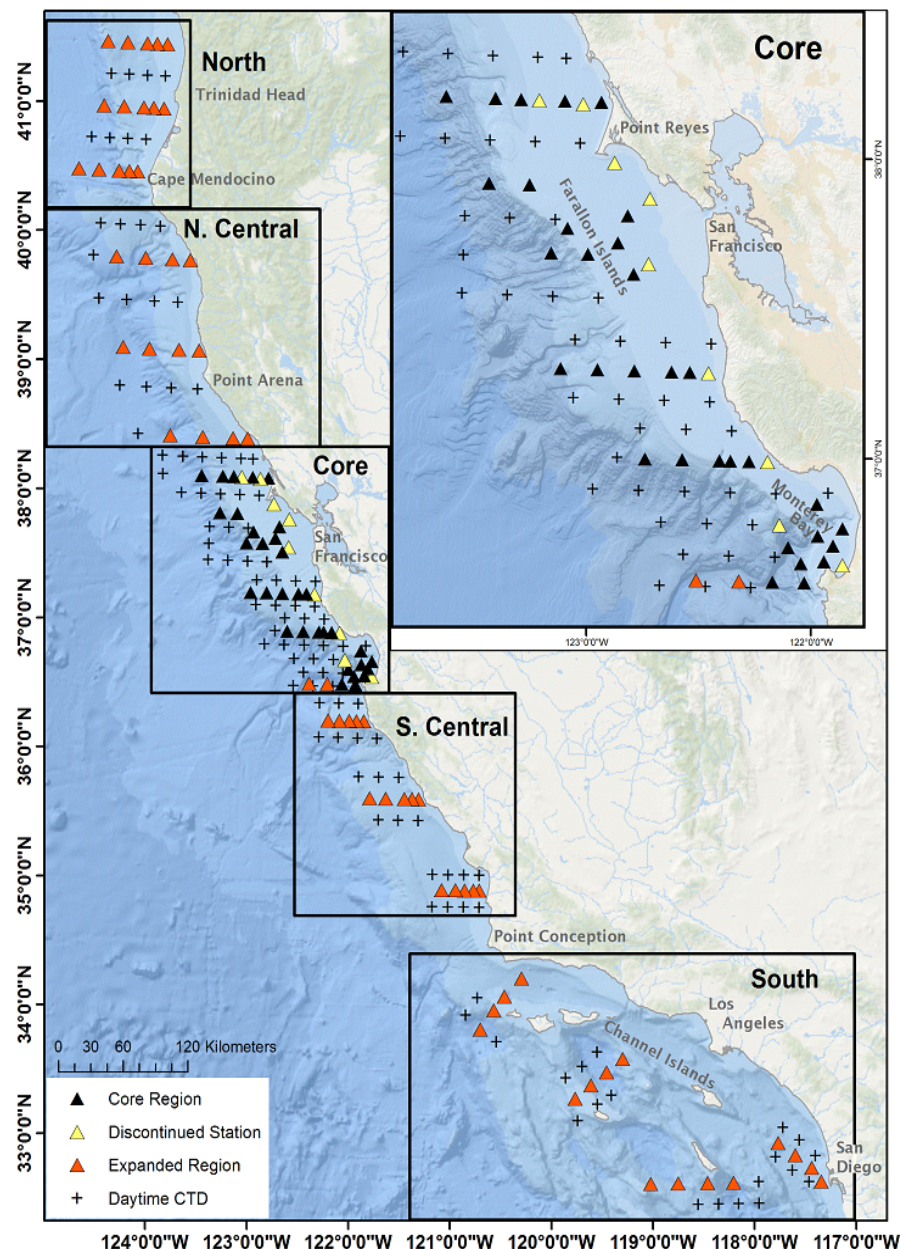
- Q1: Do the Centers/ST have clear goals and objectives for an ecosystem-related science program?
- Q4: What is the status of oceanographic, habitat, climate and ecological data required to fulfill ecosystem-related science needs? Has the Center developed strategies to obtain and manage such data?
- Q5: Is the Center appropriately analyzing and modeling ecosystem-level processes?
- Q6: Is the Center's oceanographic, habitat, climate and ecological advice sufficiently included into living marine resource management advice?
- Q7: Are the Centers'/ST's ecosystem-related science programs and products adequately peer-reviewed relative to their purpose and use?
- Q8: Does the Center/ST appropriately communicate research results and resource needs to conduct ecosystem-related science to various managers, partners, stakeholders and the public?

# Time and Place

SWFSC has surveyed a “core” area off of Central California each May-June since 1983 (33 years time series, 34<sup>th</sup> survey will sail next week on the NOAA Ship Reuben Lasker)

Expanded range in 2004 from the U.S./ Mexico border to Cape Mendocino (~45 days at sea), and to Oregon border in 2013, in recognition of need for coastwide data for most recruitment indices

Several others surveys cover northern regions (Industry/NWFSC cooperative survey 2001-2009, NWFSC 2011-2015); data are pooled for rockfish recruitment indices and other analyses, but not discussed extensively here







From 1983 through 2008 all cruises were on the NOAA Ship David Starr Jordan, since then have used 5 different vessels (including Ocean Starr, former DSJ)

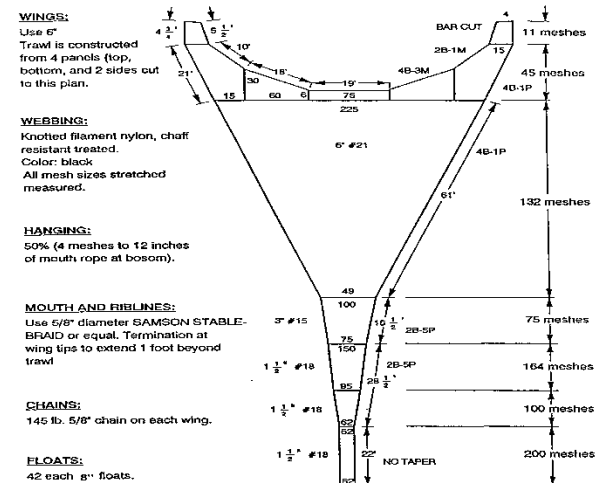


Diagram of mid-water trawl specifications.

Midwater trawling conducted at night, typically 30 meters headrope depth, using a modified Cobb trawl with 3/8" codend liner

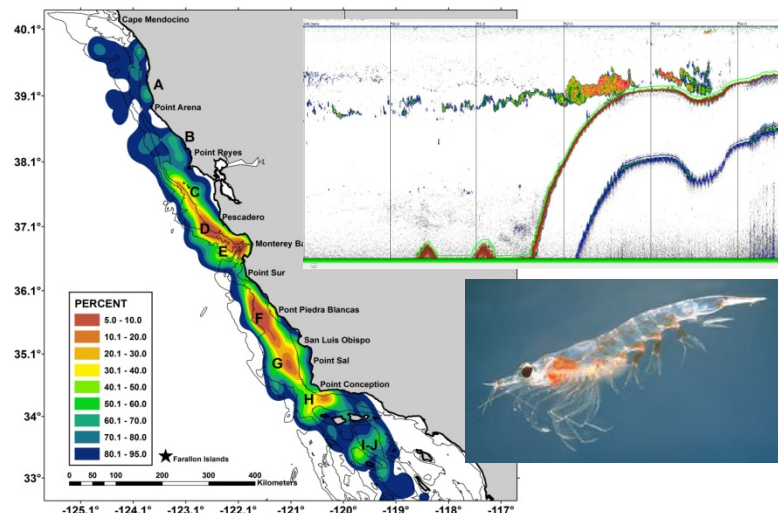
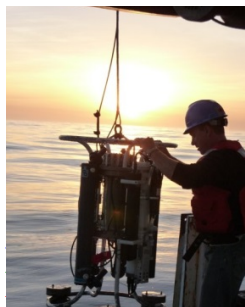
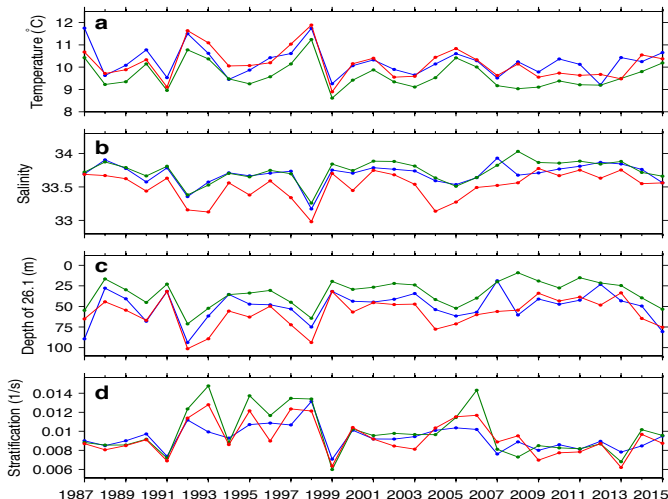




Rockfish and other species are sorted, measured and enumerated at sea

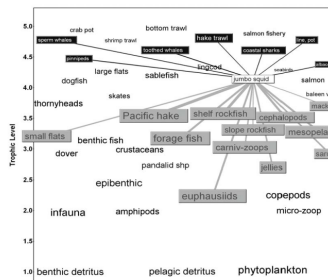


In addition to quantifying juvenile rockfish and other micronekton, research plan includes a suite of physical and biological observations

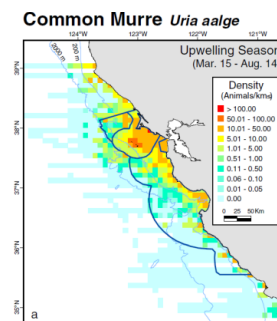
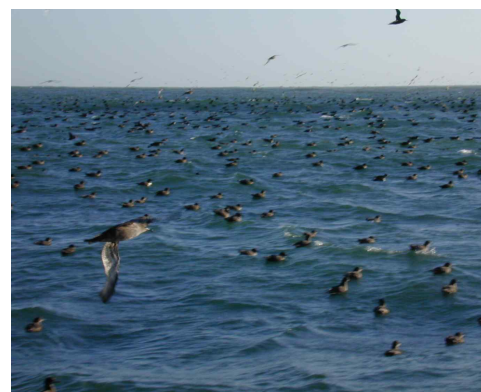


Physical Oceanography (CTD and Fluorometry), upwards of 300 casts per year (started 1987)

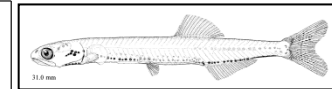
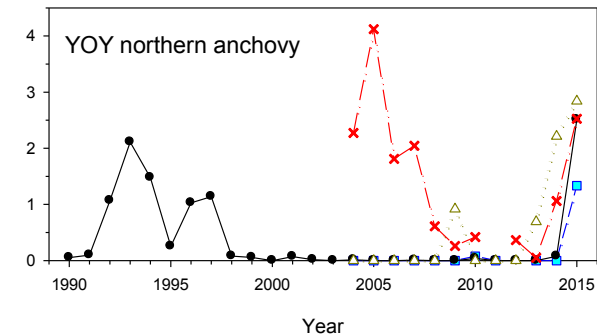
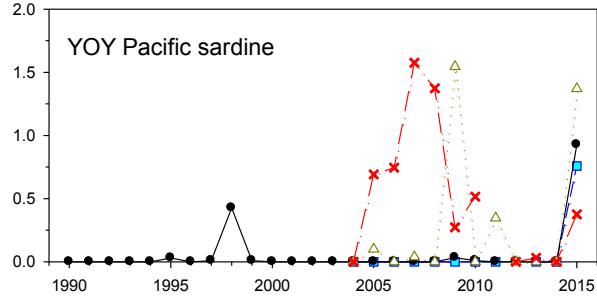
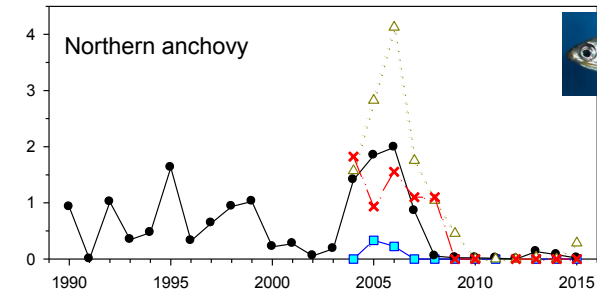
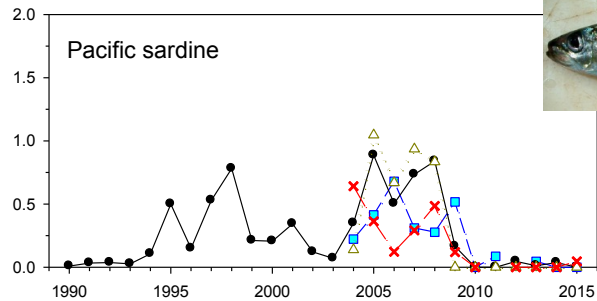
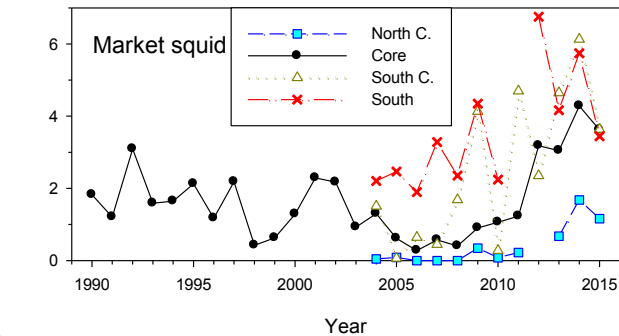
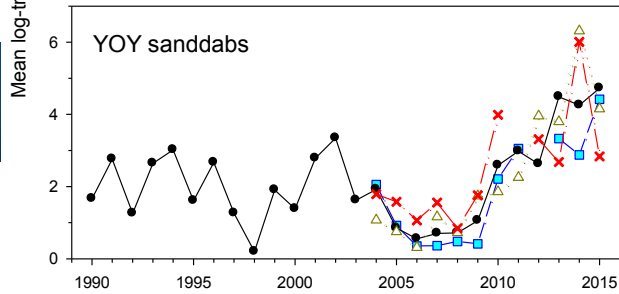
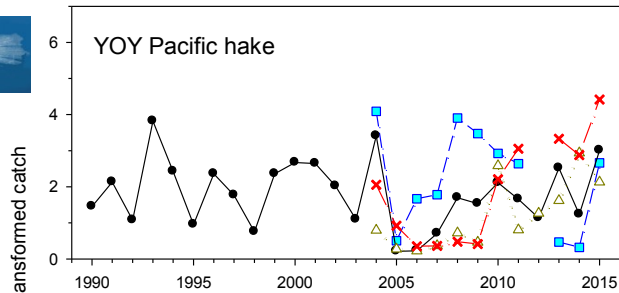
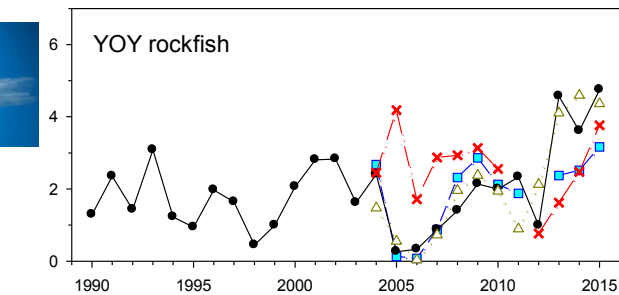
Acoustic estimates of abundance and distribution of krill and other micronekton



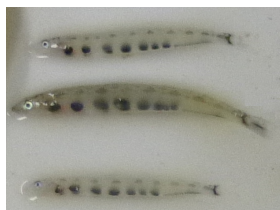
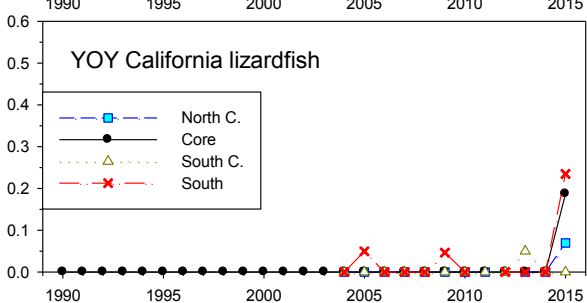
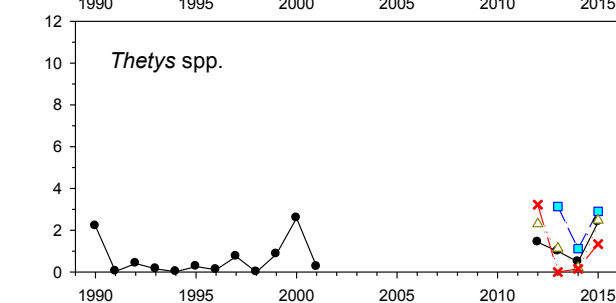
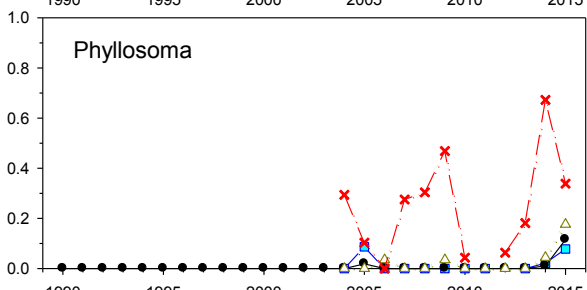
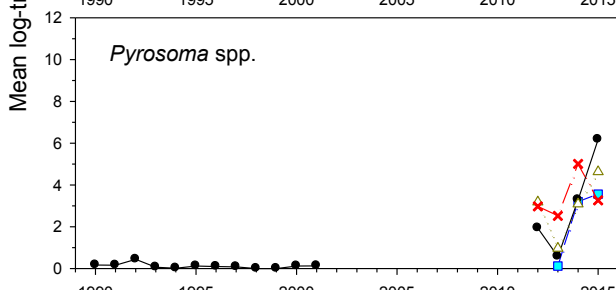
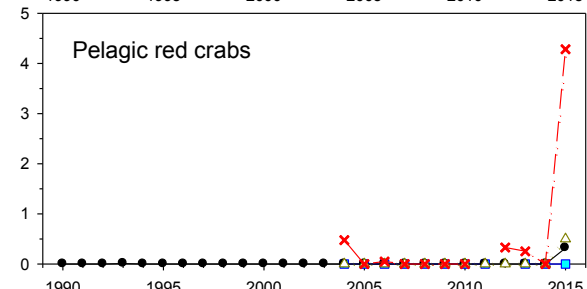
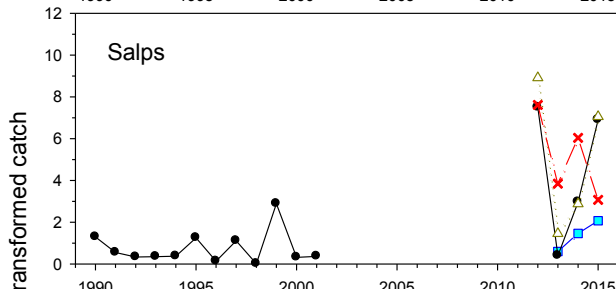
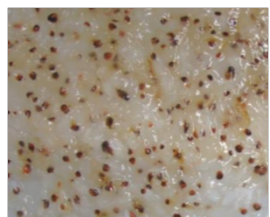
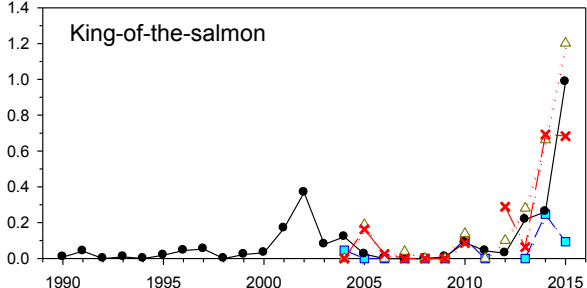
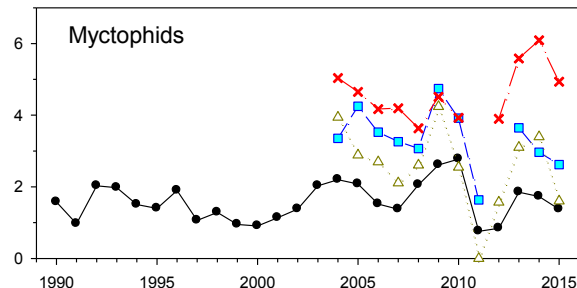
Sampling on adult rockfish and jumbo squid for life history and food habit studies



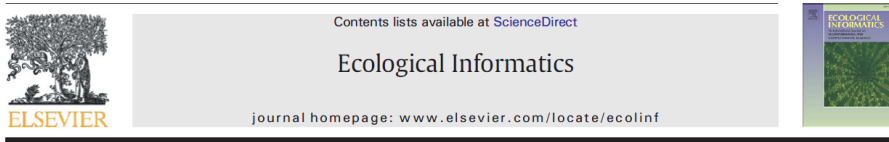
Seabird and marine mammal transects during daylight hours (data back to 1983)







# The Micronekton community



Forage species in predator diets: Synthesis of data from the California Current

Amber I. Szoboszlai<sup>a,\*</sup>, Julie A. Thayer<sup>a</sup>, Spencer A. Wood<sup>b,c</sup>, William J.

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<sup>b</sup> School of Environment and Forest Sciences, University of Washington, Box 352100, Seattle, WA 98195, USA

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<sup>d</sup> School of Aquatic and Fishery Sciences, University of Washington, Box 355020, Seattle, WA 98195, USA



**Table 2**

Forage categories and summaries of their occurrence in the database, arranged by descending number of predators and percentage for number of predators eating different prey taxa (highest (51–61 predators), high (32–41), intermediate (2–

Prey Category Scientific Name	Prey Common Name	Number of Predators	Number of Predator Samples <sup>d</sup>	Number of Citations w/ Prey in Diet
<i>Sebastes</i> spp.	rockfishes	61	-	97
<i>Engraulis mordax</i> <sup>a</sup>	northern anchovy	57	92,479	91
Euphausiacea	krill	56	-	66
<i>Clupea pallasii</i> <sup>a</sup>	Pacific herring	52	103,019	85
<i>Loligo opalescens</i>	market squid	51	59,821	69
Pleuronectidae <sup>a</sup>	righteye flounders	41	-	58
Myctophidae	lanternfishes	40	-	39
Cottidae	sculpins	40	-	60
<i>Citharichthys</i> spp. <sup>a</sup>	sanddabs (lefteye flounder)	39	-	46
Gonatidae <sup>b</sup>	gonatid squid	38	-	43
Embiotocidae	surfperches	37	-	63
<i>Merluccius productus</i>	Pacific hake	35	46,471	64
<i>Cololabis saira</i>	Pacific saury	34	22,751	39
Osmeridae	smelts	33	-	62
<i>Sardinops sagax</i> <sup>a,c</sup>	Pacific sardine	32	22,936	43
<i>Ammodytes hexapterus</i>	Pacific sandlance	32	102,399	56
Cancridae	rock crabs	30	-	20
Gadidae	codfishes	29	-	42
Octopodidae	octopods	27	-	42
Pandalidae <sup>b</sup>	pandalid shrimp	27	-	24

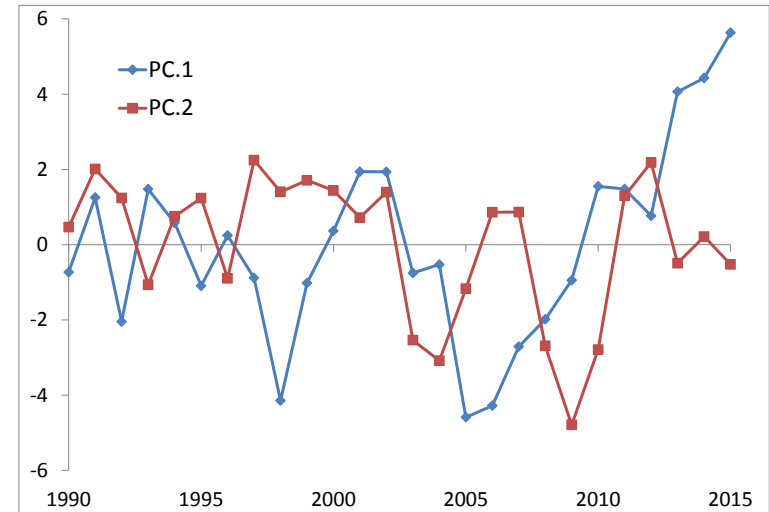
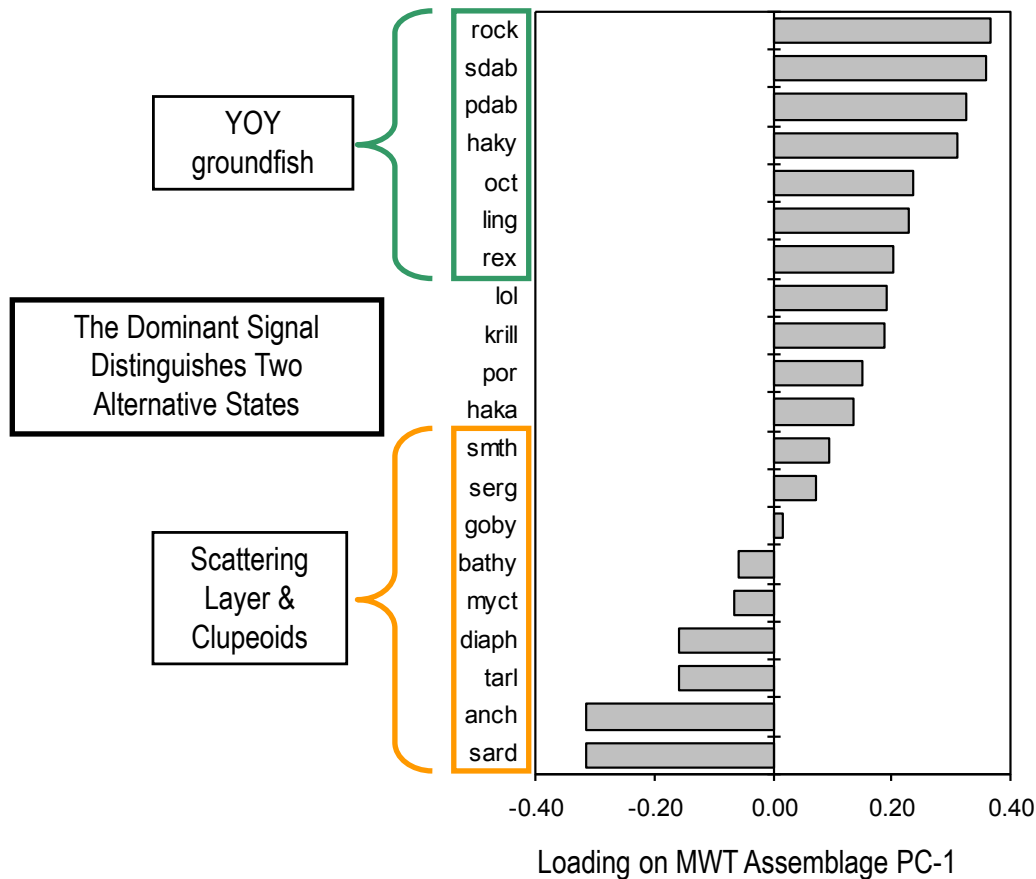
We sample 11 of the top 20 forage components in the California Current, including 8 of the top 10

(Szoboszlai et al. 2015, consistent with Ainley et al. 2015)



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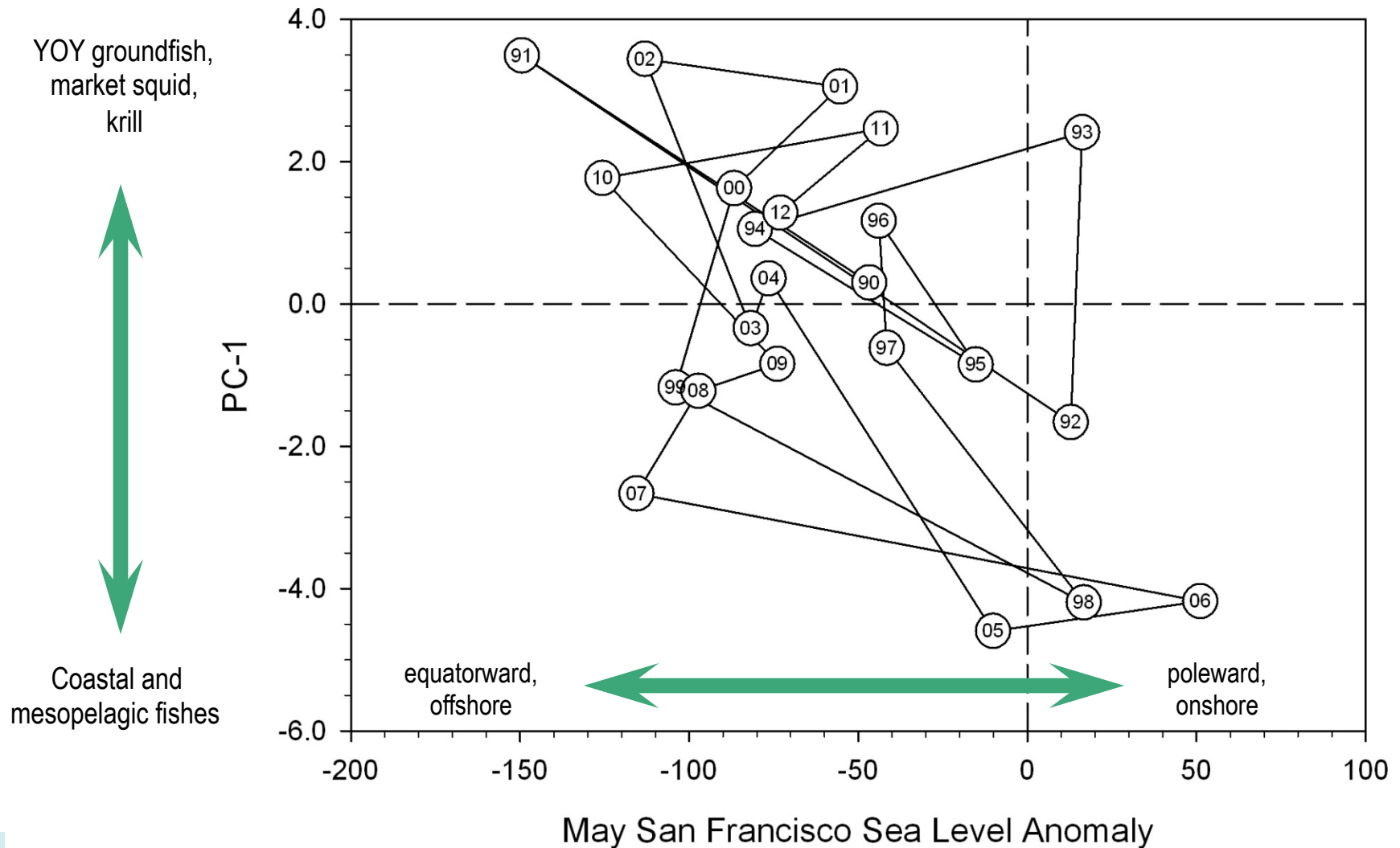
# The Midwater Trawl Forage Assemblage



PC	Eigenvalue	Proportion Variance	Cumulative Variance
1	5.73	29%	29%
2	3.93	20%	48%
3	2.44	12%	61%

Ralston et al. 2015. Long-term variation in a central California pelagic forage assemblage. *Journal of Marine Systems* 146: 26–37.

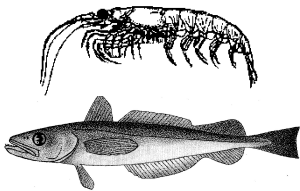
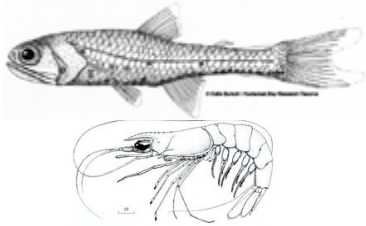
Local sea level anomalies (indicator of transport)  
are related to the species composition of the midwater trawl



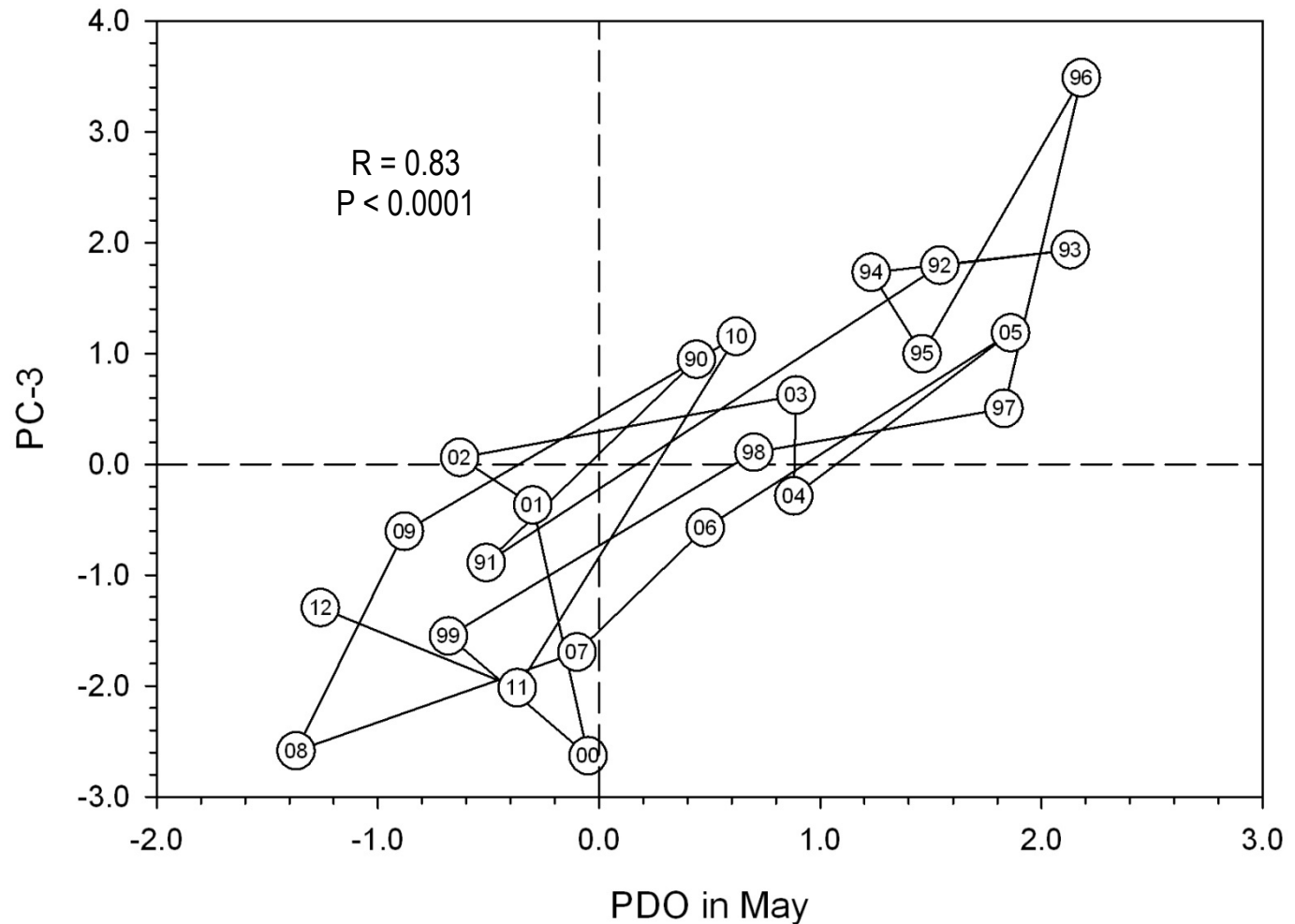


## Basin-Scale processes also affect species composition

myctophids, sergestids



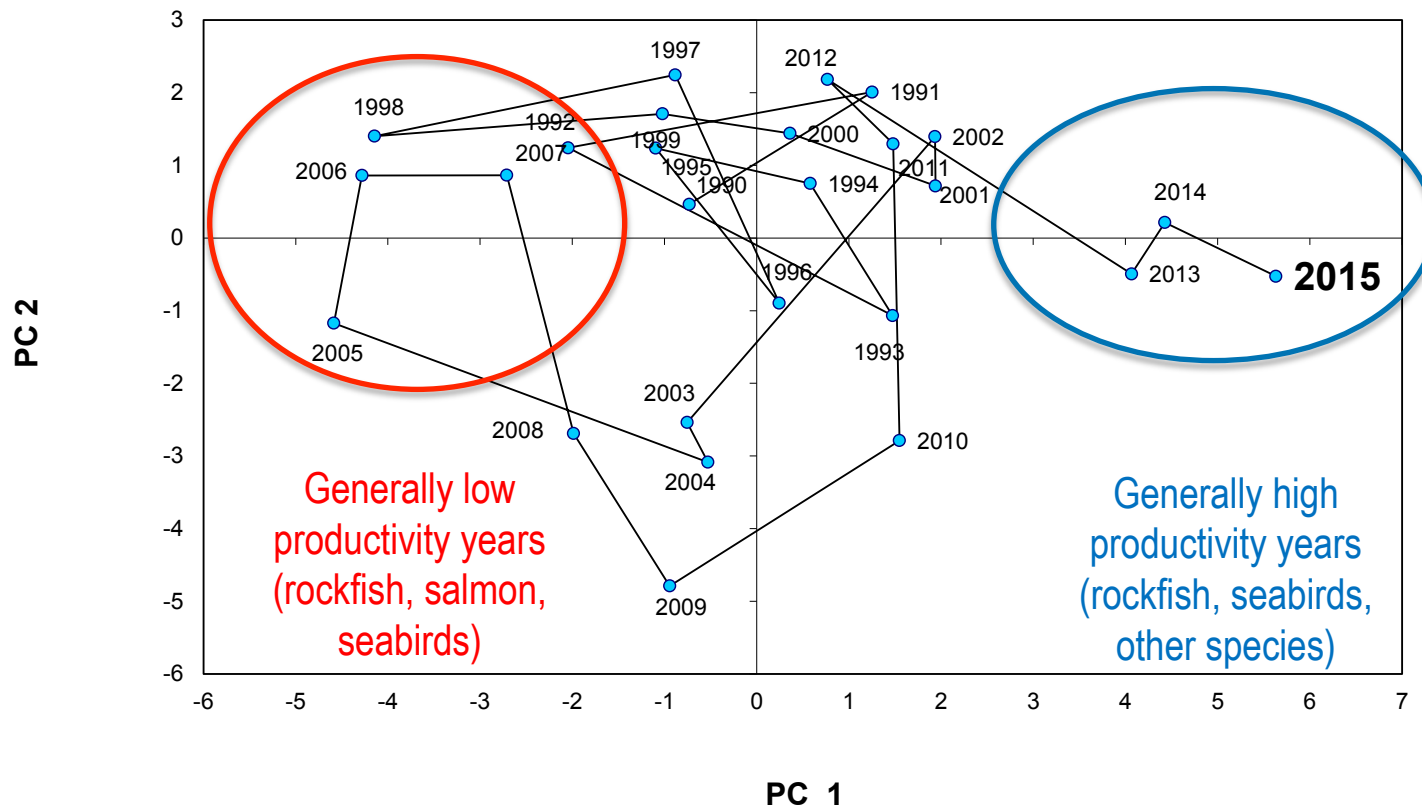
krill, adult hake



southern shift

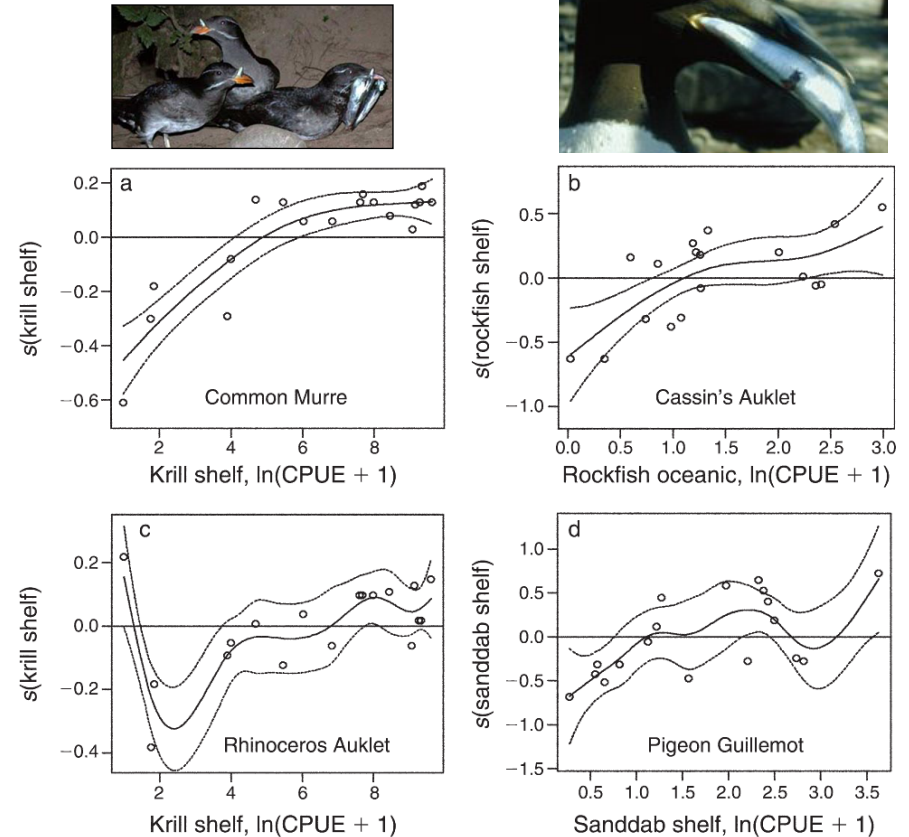
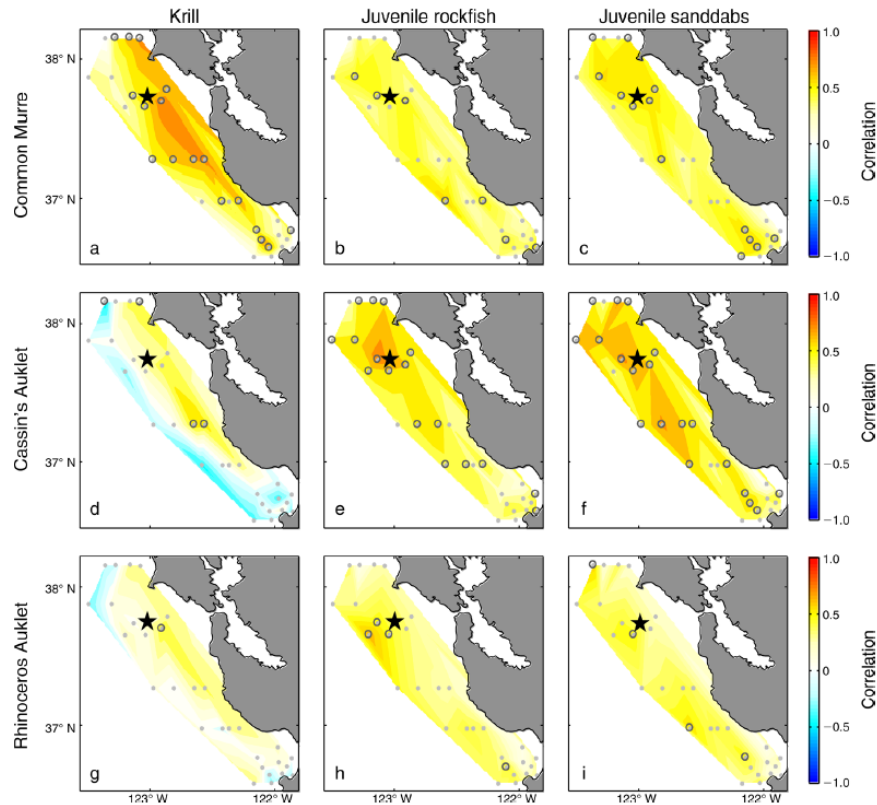


northern shift



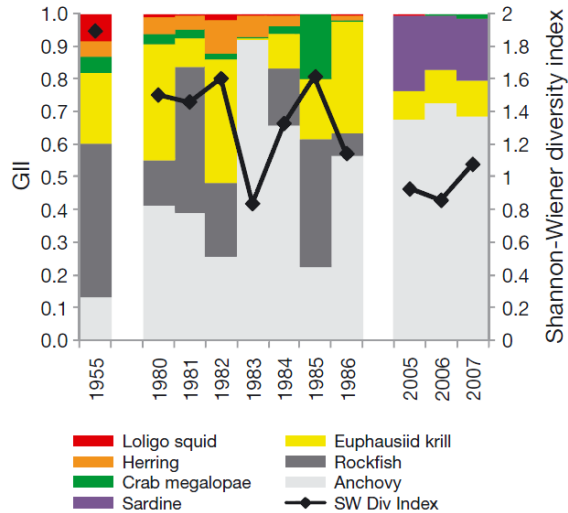
Strongly loading positive years on PC1 tend to be good recruitment years for rockfish, other groundfish and salmon, with high seabird reproductive success, while strong negative loadings tend to be low productivity years for those same species (recent years and salmon remain to be seen....)

# Long history of linking YOY rockfish and other forage abundance to seabird productivity

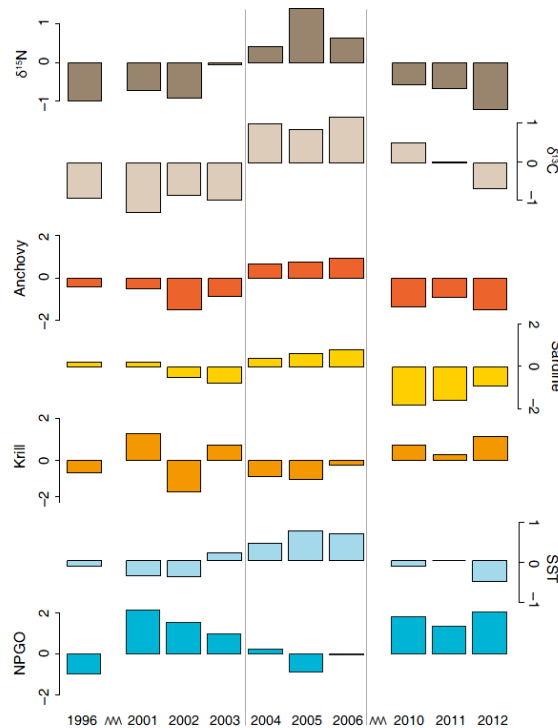


Santora et al. (2014) evaluated spatio-temporal variability in hydrographic conditions, krill, and forage fish to model predator (Farallon Island breeding seabirds) demographic responses over an 18 year period, consistent with a large number of earlier studies

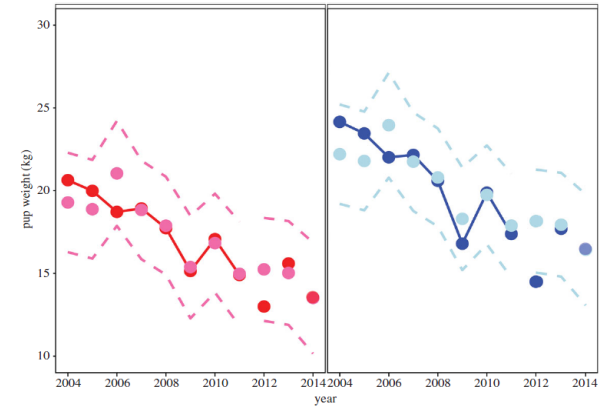
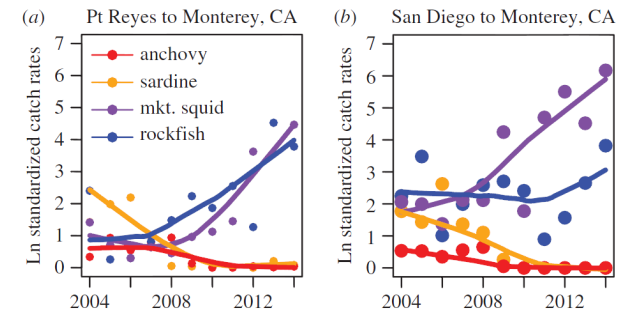
# Growing interest in linking forage indices to productivity of higher trophic level fishes, seabirds and marine mammals



Adult salmon diets  
Thayer et al. (2014)



Humpback whale diets  
Fleming et al. (2015)



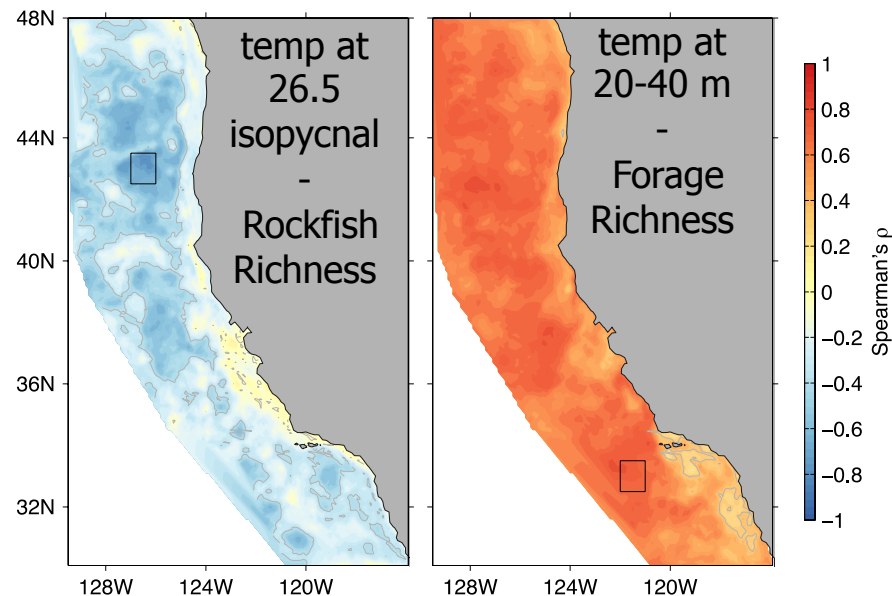
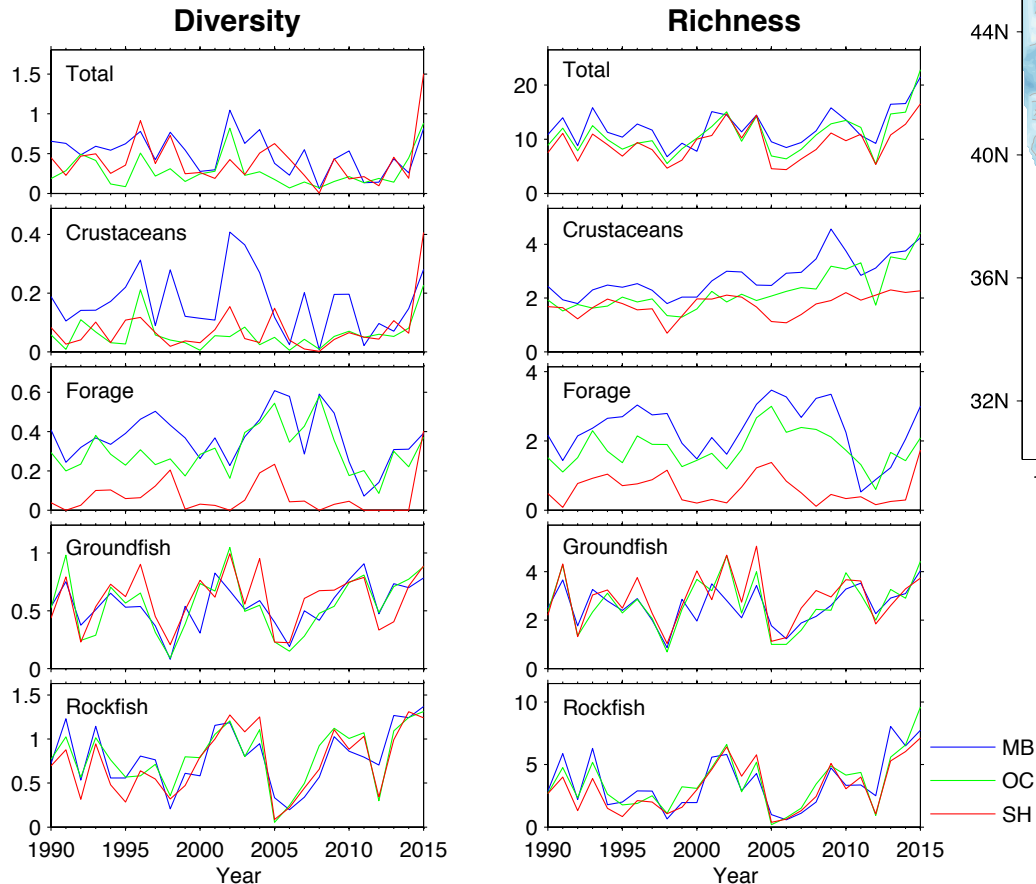
California sea lion pup weights  
McClatchie et al. (2016)





# Marine Biodiversity Observation Network (MBON)

(in collaboration with ERD, UCSC, Monterey Bay NMS, MBARI, Hopkins/Stanford)



Unusually high levels of species diversity and richness in 2015. Forage species richness are associated with the intrusion of warm surface waters, YOY groundfish associated with cooler temperatures at depth





# Dissemination



## STATE OF THE CALIFORNIA CURRENT 2014-15: IMPACTS OF THE WARM-WATER "BLOB"

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Department of Oceanography  
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GILBERTO GAXIOLA-CASTR

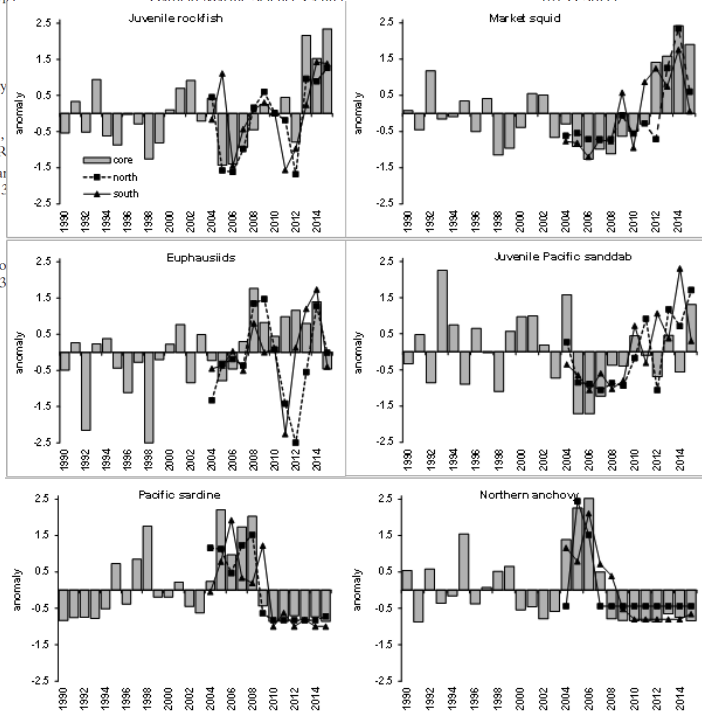
UABC-Facultad de Ciencias Mar  
Carretera Ensenada-Tijuana No. 3  
Zona Playitas, Ensenada  
Baja California, México

<sup>2</sup>CICESE

Departamento de Oceanografía Bio  
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WILLIAM T. PETERSON,  
RICHARD D. BRODEUR  
Northwest Fisheries Science Center  
National Marine Fisheries Service  
Hatfield Marine Science Center

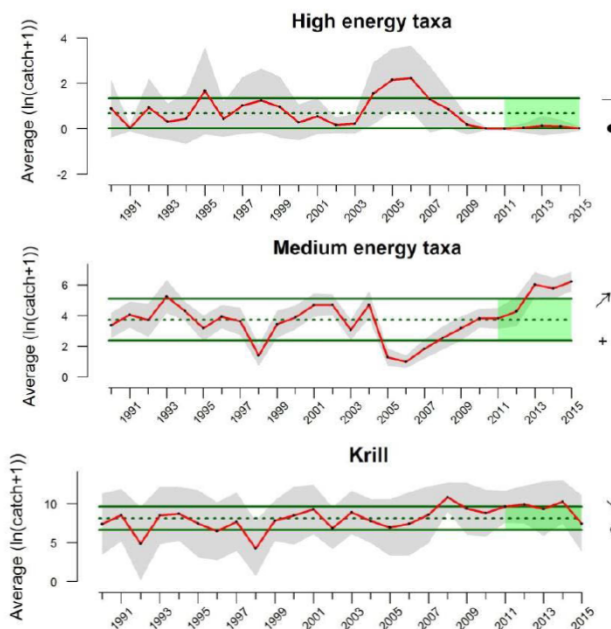
JARROD A. SANTORA,  
WILLIAM J. SYDEMAN  
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101 H Street



PICES SPECIAL PUBLICATION 4

Marine Ecosystems of the  
North Pacific Ocean 2003-2008

## Central California Current



Data and results have been included in numerous "state of the ecosystem" reports (CalCOFI, PICES, IEA), and we have collaborated with a large number of partners (University California Santa Cruz, Farallon Institute for Advanced Ecosystem Research, Romberg Center, Point Blue, MBARI, Hopkins Marine Station- Stanford, many others)



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## Summary of Terms of Reference Questions and Answers

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- Q1: Clear goals and objectives? ***Survey initiated for assessment-related goals, but has been recognized and utilized since earliest days as supporting forage/ecosystem/predator studies.***
- Q4: Status of data required to fulfill ecosystem-related science needs? ***Survey samples mid-trophic level species, many of which are critical links in the food web, in doing so we think we fill a critical data need.***
- Q5: Appropriately analyzing and modeling ecosystem-level processes? ***We have initiated process studies of environmental drivers of recruitment and abundance of the forage community, collaborated on studies relating these species to predator productivity, and collaborated with ERD and others to integrate our data into ROMS models.***
- Q6: Results included into management advice? ***Results are included in stock assessments of rockfish, in IEA and other ecosystem indicator reports provided to Council and other entities***
- Q7: Products adequately peer-reviewed? ***All products are peer reviewed (STAR Panels, literature review process)***
- Q8: Communicate results to managers, partners, others? ***Results shared with PFMC and among broad stakeholder (other researchers) community and public via CalCOFI, IEA, MBON (soon!) and others means***



# Rockfish Recruitment and Ecosystem Assessment Survey

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## ***Strengths***

- Fills an assessment need and informs process and ecosystem studies
- Staffing needs shared with partners and collaborators
- Indices of micronekton abundance/structure often relate well to top predators
- As a result, indices of increasing interest to researchers, in status reports
- Time series among the longest on West Coast, companion survey off PNW

## ***Challenges***

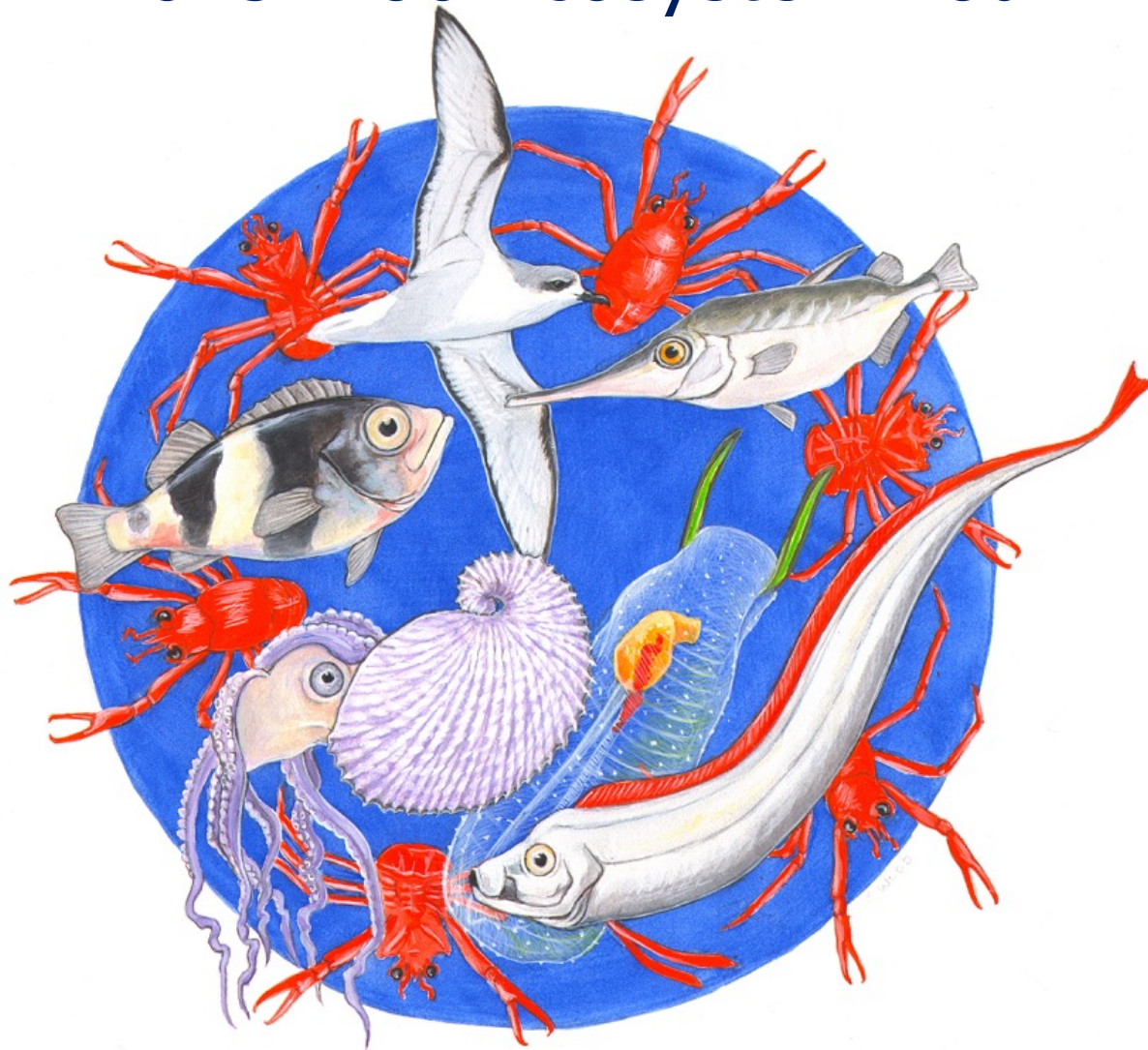
- Staff primarily constrained to conducting survey, supporting indices for assessments
- Consequently, some data relatively “underutilized” (oceanographic, acoustic)
- Survey is strongly seasonal, but seasonality is variable, and other seasons matter

## ***Strategies***

- Continue to maintain and expand partnerships for ecosystem research
- Continue/expand integration of data with ROMS, other models for process studies
- Continue to explore greater integration of research platform for other studies



# 2015 Blob Ecosystem Tour



## Questions?



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